V. "Researches on the Foraminifera."—Fourth and concluding Series. By W. B. Carpenter, M.D., F.R.S., F.G.S., F.L.S. &c. Received June 14, 1860.

(Abstract.)

The author in this communication brings to a conclusion that series of inquiries into the structural and physiological characters of *typical forms* of Foraminifera, which he had been induced to work out for the sake of turning to the account of Zoological science the valuable collections made by Mr. Jukes in the Australian Seas and by Mr. Cuming in the Philippine.

The first genus now treated of is *Polystomella*, the smaller and simpler forms of which have long been known, and of which the structure, so far as it can be elucidated by the examination of such specimens, has been already described with great care and accuracy by Professor W. C. Williamson. But in the comparatively gigantic and highly developed *Polystomella* of the Australian and Philippine series, a feature exists which is scarcely discernible in the humbler forms previously examined—that feature being the extraordinary development of the canal-system. A spiral canal runs along the inner margin of either surface of every whorl; from this canal a series of arches is given off, of which one passes down between every two adjacent segments, uniting it with the other spiral canal; whilst another set of straight branches passes directly towards the surface of the shell, through the thick calcareous deposit which covers in the depressed centre of the spire, and which extends as far as the last-formed spire. From the connecting arches, successive pairs of diverging branches proceed at frequent intervals; these, in the last whorl, make their way to the surface of the shell, and (when the shell is newly formed) open close on either side of the septal band; though, as the shell increases in thickness by subsequent deposit, the increased divergence of the branches separates their mouths from each other; and it very commonly happens that the two contiguous branches diverging from different arches meet and open by a single external pore half-way between the septal bands. When one whorl, however, has been surrounded by another, this radiating canal-system of the inner whorl does not usually continue itself directly into that of the outer (though such a continuation is not unfrequently seen), but

the diverging canals for the most part terminate in the stolons of communication between the segments of sarcode that occupy the chambers of the outer whorl.

The evidence afforded by the distribution of the canal-system in *Polystomella* is decidedly confirmatory of the view expressed by the author on a former occasion, that this peculiar set of inosculating passages is related to the formation and nutrition of those solid calcareous layers which strengthen and connect the proper walls of the chambers, and to which he has given the designation of the "intermediate skeleton."

This view derives strong confirmation from the still more extensive distribution and greater importance of the canal-system of *Calcarina*, a genus of which Mr. Cuming's Philippine collection affords a most remarkable series of illustrations. This type may be considered as closely allied to *Polystomella* in the disposition and mode of communication of its chambers, save that the spire is generally more or less inequilateral. Its "intermediate skeleton" is, however, much more developed; and it extends itself into a variable number of prolongations, sometimes simply club-shaped, sometimes more or less ramifying, which radiate in different directions from the central body, giving it somewhat the appearance of a spur-rowel, whence its generic designation. (An approach to this configuration is occasionally presented by the common *Polystomella crispa*, as also by some other species of *Polystomella*.) Now the independence of the intermediate skeleton and of the spiral system of chambers is curiously shown by the disproportionate development which they respectively exhibit the one to the other, and by their occasional complete disconnexion,—the spire altogether departing from its usual course, and (as it were) running wild, whilst the intermediate skeleton with its prolongations still present their ordinary configuration. The nutrition of the intermediate skeleton seems to be provided for by a system of large canals, freely inosculating with each other, which originate on the sides of the chambers, and are continued through the whole thickness of the intermediate skeleton, some of them passing directly to its nearest surface, whilst others are continued to the terminations of its radiating prolongations.

It is not a little remarkable that a Foraminiferous organism should present itself so extremely resembling the preceding as to be easily

mistaken for it, and yet essentially differing from it in its plan of structure. This is the case with a type of which some remarkable specimens occur in Mr. Cuming's collection, and of which some smaller examples have been kindly put into the author's hands by Dr. J. E. Gray. As it seems to be identical with the body described by Montfort under the designation *Tinoporus baculatus*, it may be right to retain that name, although it had been abandoned under the impression that it was a mere synonym of *Calcarina*. The structure of this body will be better understood after the description of a simpler form, which seems to be generally diffused through the seas of warmer latitudes, but of which the most remarkable examples present themselves in Mr. Jukes's Australian dredgings. Its shape is extremely variable, being sometimes an almost perfect sphere, in other cases resembling the lower half of a sugar-loaf, whilst in other cases again it is a very irregular depressed cone. It seems originally to have grown attached to zoophytes, corals, &c., since it frequently presents indications of such former attachment, though it is rarely to be met with otherwise than free. It is, moreover, very closely allied in structure to the body which has been termed *Polytrema miniaceum*, under the belief that it was a Polyzoan Coral, but whose Foraminiferous affinities have been already perceived by Dr. Gray, who has proposed for it the generic name of *Pustulipora*.

In the commencement of its growth, this organism seems closely to resemble *Planorbulina*, being formed of an assemblage of chambers arranged on one plane, spirally towards the centre, but irregularly clustered towards the circumference; each chamber communicating by single large septal orifices with the two contiguous chambers of the same row, whilst its walls are perforated with numerous large pseudopodian foramina. This first-formed plane, however, is afterwards covered-in above and below by numerous successive layers of similar cells, which are piled one upon another in very regular rows; the original spiral type of growth being altogether lost in these superposed layers. In this mode the organism comes to present a near relationship to the fossil genus *Orbitoides**; the principal difference being that the superposed layers are not so completely differentiated from the original median layer in *Tinoporus* as they are in *Orbitoides*.

* See the author's account of the structure of that genus in the Quarterly Journal of the Geological Society, vol. vi. 1850, p. 32.

Now in *Tinoporus baculatus* we often find columns of solid shell-substance interposed between the angular partitions of the piles of superposed cells, just as they are in *Orbitoides*, their summits being visible on the surface as projecting tubercles; these columns are perforated with pseudopodian canals, which are extensions of the pores in the walls of the chambers over which they lie. And the peculiar stellate projections which give to this species so much the aspect of a *Calcarina* are for the most part formed of a similar growth; for though the chambered structure is continued for a short distance as a conical protuberance into the base of each, yet this cone is invested and extended by a sheath of solid shell-substance, which is perforated by pseudopodian tubes extending through it from the chambers.

The last type of Foraminiferous structure described in this communication is one which appears to furnish a highly interesting link of connexion between *Foraminifera* and *Sponges*. Its nature was at first entirely misunderstood; the specimens in Mr. Cuming's collection having been supposed, not only by Mr. Cuming, but by other conchologists, to be shells of a sessile Cirripede. Their external resemblance might readily justify such an inference; since they are irregular cones, apparently composed of distinct valves, attached by a spreading base to the surface of shells or corals, and having a single orifice at their apex. A careful examination of the interior structure, however, makes it evident that the shell is multilocular, and that it is formed upon the type of the *Helicostègue* Foraminifera, closely resembling *Globigerina* in the commencement of its growth; the supposed 'valves' being the walls of the outer whorl, the chambers of which are very large, and are partially subdivided by incomplete septa. All the principal chambers communicate by orifices of their own with a sort of central funnel which leads to the external orifice; and thus their relation to it is very much that of the separate orifices of the chambers of *Globigerina* to its umbilicus. The cavities of the chambers are occupied by a spongeous tissue, which contains siliceous spicules; and although the possibility that this spongy substance may be parasitic must not be lost sight of, yet reasons are given which seem to render it almost certain that this is the proper body of the organism, on which Dr. Gray, who first discerned its true affinities, has conferred the generic name of *Carpenteria*.

The author concludes with some general observations upon the

mutual affinities of the "typical forms" of Foraminifera whose structure he has now elucidated; and he sums up the evidence which his examination of them has furnished in regard to the very wide range of variation which seems especially to characterize this group,—avowing his conviction that the only classification of it which can approach to a really natural arrangement, will be one founded upon the idea of "descent with modification" as the means by which an almost infinite variety of special forms has been evolved from a few fundamental types.

June 21, 1860.

Sir BENJAMIN C. BRODIE, Bart., President, in the Chair.

Frederick Augustus Abel, Esq., Thomas Baring, Esq., John Frederic Bateman, Esq., Edward Brown-Séquard, M.D., Richard Christopher Carrington, Esq., and Roundell Palmer, Esq., were admitted into the Society.

In accordance with notice given at the last Meeting, the Right Honourable George Augustus, Earl of Sheffield, was proposed for election and immediate ballot; and the ballot having been taken, his Lordship was declared duly elected.

The following communications were read:—

I. "Experimental Researches on various questions concerning Sensibility." By E. Brown-Séquard, M.D. Communicated by Dr. Sharpey, Sec. R.S. Received May 24, 1860.

The first question I propose to examine relates to the duration of sensibility in parts of the body completely deprived of the circulation of blood.

This question has hitherto received but little attention from physiologists. It is true that many experiments have been made to ascertain how long sensibility remains in animals in which circulation is stopped by the application of a ligature round the large blood-vessels of the heart; but I do not know of any special research upon the duration of sensibility in a nerve in which there is a suspension of